Claims

Cancel claims 1 to 74.

75. (Withdrawn) Endoscopic device comprising a system for measuring the distance between and the relative alignment of two objects located at two different locations along the length of said endoscopic device, said endoscopic device comprising:

one or more transducers or arrays of transducers, functioning as transmitters of ultrasonic signals, located on, or near, the first of said objects and one or more transducers or arrays of transducers, functioning as receivers of said ultrasonic signals, located on, or near, the second of said objects.

76. (Previously Presented) Endoscopic device comprising a system for measuring the distance between and the relative alignment of two objects located at two different locations along the length of said endoscopic device, said endoscopic device comprising: one or more single ultrasonic transducers, used to both transmit and receive the ultrasonic signals, mounted on, or near, the first object and at least one reflector ~~is~~ mounted on, or near, the second object, said reflector being suitable to reflect back a pattern that can be translated into the position and orientation of said objects relative to each other.

77. (Previously Presented) Endoscopic device according to claim 76, wherein the reflector comprises two, or more, parallel reflecting planar surfaces intersected, at an angle of 90 degrees or less, by one or more planes to form one, or more, step-like configurations.

78. (Previously Presented) Endoscopic device according to claim 76, wherein the reflector comprises two, or more, parallel reflecting planar surfaces separated by perpendicular surfaces to form one, or more, step-like configurations with a cylindrical symmetry created by drilling coaxial bores of different diameters.

79. (Previously Presented) Endoscopic device according to claim 77, wherein some or all of the steps in the reflector have different depths and/or different lengths and/or different cross-sections.

80. (Previously Presented) Endoscopic device according to claim 76, wherein two reflectors are mounted at right angles to each other.

81. (Withdrawn) Endoscopic device according to claim 75, wherein a single transducer is used for transmitting an ultrasound signal and a second transducer is used for receiving said signal in order to determine the distance between said transmitter and said receiver by measuring the time of flight of said signal.

82. (Withdrawn) Endoscopic device according to claim 75 wherein a minimum of three transmitting ultrasonic transducers are mounted in a predetermined geometrical arrangement on, or near, the first object and a minimum of three receiving ultrasonic transducers are mounted in the same predetermined geometrical arrangement on, or near, the second object and the objects are aligned when the intensity of all of the individual received signals is maximized.

83. (Withdrawn) Endoscopic device according to claim 82, wherein the transmitting transducers are focusing transducers that produce focused ultrasonic beams.

84. (Withdrawn) Endoscopic device according to claim 82, wherein each of the transmitting transducers transmits a unique signal comprising a unique sequence of data bits, and wherein the objects are aligned when each of said unique signals is received by the mating receiving transducer and the intensities of all the signals are equal to predetermined values.

85. (Withdrawn) Endoscopic device according to claim 75, wherein the relative alignment of the two objects is determined by use of triangulation techniques.

86. (Withdrawn) Endoscopic device according to claim 75, wherein the ultrasonic transducers are single element transducers.

87. (Withdrawn) Endoscopic device according to claim 75, wherein the ultrasonic transducers are composed of an array of elements.

88. (Withdrawn) Endoscopic device according to claim 75, wherein an aperture is placed before the transmitting ultrasonic transducers or a diverging transducer is used to cause the transmitted ultrasonic beam to diverge.

89. (Withdrawn) Endoscopic device according to claim 75, wherein two or more ultrasonic transmitters are mounted on, or near, the first object, said transmitters being mounted at a predetermined, fixed angle such that the transmitted beams intersect at a point in front of said first object and one ultrasonic receiver is mounted on, or near, the second object which is displaced according to information received from intensity measurements until said receiver is located at said intersection point, thus achieving proper positioning of said objects relative to each other.

90. (Withdrawn) Endoscopic device according to claim 75, wherein two or more ultrasonic receivers-are mounted on, or near, the first object and one ultrasonic transmitter is mounted on, or near, the second object said transmitter being composed of an array that produces a beam that can be steered by electronic means in accordance with information received from measurements of the angles to said receivers until said angles are equal to predetermined values, thereby to achieve proper positioning of said objects relative to each other.

91. (Previously Presented) Endoscopic device according to claim 77, wherein, for the case of reflectors having two or more steps, the total width of the steps does not exceed the beam width of the ultrasonic beam that impinges upon the reflector.

92. (Previously Presented) Endoscopic device according to claim 77, wherein the distance between reflecting layers (step height) is equal or greater than the echo duration multiplied by the sound velocity in the medium divided by two.

93. (Previously Presented) Endoscopic device to claim 76, wherein the reflecting surfaces of the reflectors are surrounded with ultrasonic energy absorbing material.

94. (Previously Presented) Endoscopic device according to claim 77, wherein said endoscopic device is adapted to position the two objects within a human or animal body separated by at least one layer of tissue.

95. (Previously Presented) Endoscopic device according to claim 94, wherein the air gaps, which occur between the tissue and the

reflecting surfaces of the reflector are filled with a hard or flexible material having an acoustical coefficient matching that of said tissue.

96. (Withdrawn) Endoscopic device according to claim 75, wherein said endoscopic device comprises an anvil unit of a stapler system, which is one of the objects to be aligned, and a stapler deployment unit containing a stapler cartridge, which is the other object.

97. (Previously Presented) An endoscopic device according to claim 149, wherein one or more reflectors of ultrasonic waves is created on or within or as an integral part of a surface of the stapler cartridge.

98. (Withdrawn) An endoscopic device according to claim 96, containing one or more channels created throughout the height of the stapler cartridge for guiding an ultrasonic signal from a transmitter to a receiver of said signal.

99. (Withdrawn) An endoscopic device according to claim 96, wherein the transducer that transmits only, receives only, or both transmits/receives is mounted into the stapler anvil unit or the cartridge unit.

100. (Canceled) ~~An endoscopic device according to claim 75 comprising a reflector of ultrasonic energy suitable to reflect back a pattern that can be translated into the position and orientation of said objects relative to each other.~~

101. (Canceled) ~~An endoscopic device according to claim 100, wherein the reflector comprises two, or more, parallel reflecting~~

~~planar surfaces intersected, at an angle of 90 degrees or less, by one or more planes to form one, or more, step-like configurations.~~

102. (Canceled) ~~An endoscopic device according to claim 100, wherein the reflector of ultrasonic energy comprises two, or more, parallel reflecting planar surfaces separated by perpendicular surfaces to form one, or more, step-like configurations with a cylindrical symmetry created by drilling coaxial bores of different diameters.~~

103. (Canceled) ~~An endoscopic device according to claims 101, wherein some or all of the steps in the step reflector have different depths and/or different lengths and/or different cross-sections.~~

104. (Canceled) ~~A method of using the system of the endoscopic device of claim 1 for measuring the distance between and/or the relative alignment of two objects located at two different locations along the length of said endoscope said method comprising the use of elements chosen from the group consisting of:~~

~~a) transducers; and~~

~~b) reflectors;~~

~~wherein said elements are located on said endoscope in one of the following arrangements:~~

~~a) one or more transducers or arrays of transducers, functioning as transmitters of ultrasonic signals, are located on, or near, one of said objects and one or more transducers or arrays of transducers, functioning as receivers of said ultrasonic signals, are located on, or near, the other of said objects; or~~

~~b) the arrangement of a) wherein, at least one of the transducers or arrays of transducers, functioning as receivers of ultrasonic signals, is replaced by a reflector~~

~~and at least one of the transducers or arrays of transducers, functioning as transmitters of said ultrasonic signals, also functions as a receiver of said signals.~~

105. (Previously Presented) A method for measuring the distance between two objects located at two different locations along the length of an endoscopic device, said method comprising the steps of:

a) providing an endoscopic device according to claim 76;
b) activating the ~~a~~ single ultrasonic transducer used to both transmit and receive the ultrasonic signals to transmit an ultrasonic signal;
c) activating the single ultrasonic transducer used to both transmit and receive the ultrasonic signals to receive an ultrasonic signal reflected from the reflector;
d) measuring the time of flight of said signal;.
e) determining the distance between said transmitter and said reflector from said measured time and,
f) determining the distance between said two objects from the distance between said transmitter and said reflector.

106. (Withdrawn) A method for measuring the distance between two objects located at two different locations along the length of an endoscopic device, said method comprising the steps of:

a) providing an endoscopic device according to claim 75;
b) activating a single transducer functioning as a transmitter of ultrasonic signals to transmit an ultrasonic signal;
c) activating a second transducer functioning as a receiver of ultrasonic signals to receive said ultrasonic;

d) measuring the time of flight of said signal;

e) determining the distance between said transmitter and said receiver from said measured time; and,

f) determining the distance between said two objects from the distance between said transmitter and said receiver.

107. (Previously Presented) A method according to claim 105, wherein the time of flight is measured by starting a clock simultaneously with the start of transmission of an ultrasonic signal and stopping said clock when the received signal rises above a predetermined threshold.

108. (Previously Presented) A method according to claim 105, wherein the time of flight is measured by transmitting an ultrasonic signal, sampling the received signal, and carrying out a cross-correlation with a stored reference signal.

109. (Previously Presented) A method according to claim 108, comprising transmitting an ultrasonic signal consisting_of a random sequence of pulses.

110. (Previously Presented) A method according to claim 109, comprising modulating the transmitted random sequence of by digital modulation.

111. (Previously Presented) A method according to claim 110, comprising carrying out_the digital modulation by means of the PSK method.

112. (Withdrawn) A method according to claim 106, wherein step d) comprises measuring the spatial phase difference between the

transmitted and received wave and step e) comprises determining the distance between the transmitter and the receiver from said measured spatial phase difference.

113. (Withdrawn) A method according to claim 106, comprising measuring the distance between the transmitter and the receiver by using a transducer capable of transmitting ultrasonic signals at two different wavelengths and measuring the time of flight when the distance is relatively large or measuring the spatial phase difference between the transmitted and received wave when the distance between transmitter and receiver is less than one wavelength.

114. (Withdrawn) A method according to claim 106, comprising determining the distance between the transmitter and the receiver by using a transducer capable of transmitting ultrasonic signals at least two different wavelengths and measuring the ratio of the intensities of the received signals at each wavelength.

115. (Withdrawn) A method according to claim 106, comprising mounting a minimum of three transmitting ultrasonic transducers in a predetermined geometrical arrangement on, or near, the first of the objects and a minimum of three receiving ultrasonic transducers in the same predetermined geometrical arrangement on, or near, the second object~~.~~, wherein the objects are aligned when the intensity of all of the individual received signals is maximized.

116. (Withdrawn) A method according to claim 115, comprising carrying out the alignment procedure within the Fresenel zone of the transmitted ultrasonic beams.

117. (Withdrawn) A method according to claim 115, comprising using focusing transducers that produce focused ultrasonic beams as the transmitting transducers.

118. (Withdrawn) A method according to claim 115, comprising transmitting a unique signal comprising a unique sequence of data bits from each of the transmitting transducers, whereupon the objects are aligned when each of said unique signals is received by the mating receiving transducer and the intensities of all the signals are equal to predetermined values.

119. (Previously Presented) A method according to claim 105, comprising using triangulation techniques to determine the relative distance and alignment of the two objects.

120. (Currently Amended) A method according to claim 119, comprising accomplishing the relative alignment of the two objects in three-dimensional space by: providing ~~one ultrasonic transmitter~~ <u>a single ultrasonic transducer, used to both transmit and receive the ultrasonic signals</u> located on, or near, the first of said objects and three ~~ultrasonic receivers~~ <u>reflectors</u> located on, or near, the second object, measuring the lengths of the sides of the triangles formed by said transmitter<u>/receiver</u> and each pair of said ~~receivers~~ <u>reflectors</u>, and moving said transmitter<u>/receiver</u> until a predetermined relationship between said lengths of said sides of said triangles is achieved.

121. (Currently Amended) A method according to claim 119, comprising accomplishing the relative alignment of the two objects in two-dimensional space by: providing ~~one ultrasonic transmitter~~ <u>a single ultrasonic transducer, used to both transmit and receive the ultrasonic signals</u> located on, or near, the first of said objects

and two ~~ultrasonic receivers~~ reflectors located on, or near, the second object, measuring the length of the sides of the triangles formed by said transmitter/receiver and each pair of said ~~receivers~~ reflectors, and moving said transmitter/receiver until a predetermined relationship between said lengths of said sides of said triangles is achieved.

122. (Currently Amended) A method according to claim 120, comprising replacing the ~~ultrasonic transmitter~~ single ultrasonic transducer, used to both transmit and receive the ultrasonic signals and the three ~~ultrasonic receivers~~ reflectors by three ~~transmitters~~ ultrasonic transducers, used to both transmit and receive the ultrasonic signals and one ~~receiver~~ reflector.

123. (Previously Presented) A method according to claim 119, comprising using single element ultrasonic transducers.

124. (Previously Presented) A method according to claim 119, comprising using ultrasonic transducers comprised of an array of elements.

125. (Currently Amended) A method according to claim 119, comprising placing an aperture before the transmitting ultrasonic ~~transducers~~ transducer or using a diverging transducer to cause the transmitted ultrasonic beam to diverge.

126. (Withdrawn) A method according to claim 106, comprising mounting two or more ultrasonic transmitters on, or near, the first of the objects, at a predetermined, fixed angle such that the transmitted beams intersect at a point in front of said first object and mounting one ultrasonic receiver or on, or near, the second object and then displacing said second object according to

information received from intensity measurements until said receiver is located at said intersection point, thus achieving proper positioning of said objects relative to each other.

127. (Withdrawn) A method according to claim 126, comprising causing the intersection point of the transmitted beams to be located within the Fresnel zone of the ultrasonic transducers.

128. (Withdrawn) A method according to claim 126, comprising using focused ultrasonic transducers and mounting said ultrasound transducers such that the intersection point of the transmitted beams is located at the focal points of said transducers.

129. (Withdrawn) A method according to claim 106, comprising mounting two or more ultrasonic receivers on, or near, the first of the objects and one ultrasonic transmitter on, or near, the second object, wherein said transmitter is composed of an array that produces a beam that can be steered by electronic means in accordance with information received from measurements of the angles to said receivers and said beam is steered until said angles are equal to predetermined values, thereby achieving proper positioning of said objects relative to each other.

130. (Previously Presented) A method according to claim 105, comprising mounting a single ultrasonic transducer, used to both transmit and receive the ultrasonic signals on, or near, the first object and at least one reflector, which reflects back a pattern that can be translated into the position and orientation of said objects relative to each other, on, or near, the second object.

131. (Previously Presented) A method according to claim 130, wherein the reflector comprises two, or more, parallel reflecting planar surfaces intersected, at an angle of 90 degrees or less, by one or more planes to form one, or more, step-like configurations.

132. (Previously Presented) A method according to claim 130, wherein the reflector comprises two, or more, parallel reflecting planar surfaces separated by perpendicular surfaces to form one, or more, step-like configurations with a cylindrical symmetry created by drilling coaxial bores of different diameters.

133. (Previously Presented) A method according to claim 131, wherein some or all of the steps in a two or more step reflector have different depths.

134. (Previously Presented) A method according to claim 130, comprising mounting_two reflectors at right angles to each other.

135. (Previously Presented) A method according to claim 131, wherein, the reflectors have two or more steps and the total width of the steps does not exceed the beam width of the ultrasonic beam that impinges upon the reflector.

136. (Previously Presented) A method according to claim 131, wherein the distance between reflecting layers (step height) is equal or greater than the echo duration multiplied by the sound velocity in the medium divided by two.

137. (Previously Presented) A method according to claim 105, comprising surrounding the reflecting surfaces of the reflectors with ultrasonic energy absorbing material.

138. (Previously Presented) A method according to claim 131, comprising using the endoscopic device to position the two objects within a human or animal body such that they are separated by at least one layer of tissue.

139. (Previously Presented) A method according to claim 138, comprising filling the air gaps, which occur between the tissue and the reflecting surfaces of the reflector_with a hard or flexible material having an acoustical coefficient matching that of said tissue.

140. (Withdrawn) A method according to claim 106, wherein the distance between the transmitter and the receiver is measured by the following steps:

- generating a repetitive series of short electrical pulses or bursts of electrical pulses;
- amplifying said pulses;
- applying said amplified electric pulses to a <u>first</u> transducer which converts the electrical energy to ultrasonic energy;
- allowing said ultrasonic energy to propagate, in the form of a relatively narrow beam, through a medium, until it encounters a second transducer;
- receiving said ultrasonic energy by said second transducer which converts it to an electrical signal;
- amplifying and filtering said electrical signal;
- digitizing said signal;
- temporarily storing the sampled data in a separate buffer of a first-in first-out (FIFO) buffer or fast memory;
- transferring the data from the FIFO or fast memory into the main computer memory;

- correlating the data in each buffer with a predefined reference signal pattern stored in a computer memory;
- determining the time of flight of the ultrasonic signal from the index of said buffer where the correlation with said reference signal has its maximum value; and,
- determining the distance from said time of flight.

141. (Withdrawn) A method according to claim 140, comprising generating the predefined reference signal from a properly chosen mathematical function.

142. (Withdrawn) A method according to claim 140, comprising measuring an actual received ultrasonic signal and storing it in the computer memory to serve as the predefined reference signal.

143. (Previously Presented) A method according to claim 105, wherein the alignment of the two objects relative to each other is determined by the following steps:
- using a single transducer as the transmitter/receiver of the ultrasonic beam and a reflector having at least one-step, which will give at least two distinct signals in the return beam;
- correlating the signals stored in the computer main memory with those of the predefined reference signal in the computer memory;
- determining the step depths from the buffers corresponding to said maxima of said correlations, wherein, at least two local maxima of the correlation must exist and the difference(s) between them must correspond to the known depth(s) of the step(s);
- if the measured depth(s) of the step(s) do not agree with the known depth(s) of said step(s), then moving

the transducer relative to the reflector and carrying out the correlation again; and

- when the measured depth(s) of the step(s) do agree with the known depth(s) of said step(s), then use the results of the correlation to determine the energy relation between said signals in said buffers.

144. (Previously Presented) A method according to claim 143, comprising using_the intensity maxima from the buffer to determine the alignment.

145. (Previously Presented) A method according to claim 143, comprising using_the ratio of the integration of the echoes to determine the alignment.

146. (Previously Presented) A method according to claim 105, wherein the displacement of the objects relative to each other is determined and changed by the following steps:

a) using a single transducer as the transmitter/receiver of the ultrasonic beam and a reflector having at least two-steps of different depths, which will give at least three distinct echoes in the return beam;
b) determining that the objects are not aligned if less than the expected number of echoes is returned;
c) determining the depth of the steps from the returned echoes;
d) comparing the measured depth with the known depths of the reflector, to determine the portion of the reflector upon which the ultrasonic beam impinges;
e) check that the ratio of energy of the two echoes that match the step depth are within a certain relation;

f) using the information obtained in the steps (d) and (e), to move the transmitter relative to the reflector; and,

g) repeating steps (b) to (f) until the transmitter is positioned directly in front of the reflector.

147. (Previously Presented) Endoscopic device according to claim 76, wherein two or more ultrasonic transmitter/receivers are mounted on, or near, the first object, said transmitter/receivers being mounted at a predetermined, fixed angle such that the transmitted beams intersect at a point in front of said first object and one ultrasonic reflector is mounted on, or near, the second object which is displaced according to information received from intensity measurements until said reflector is located at said intersection point, thus achieving proper positioning of said objects relative to each other.

148. (Previously Presented) Endoscopic device according to claim 76, wherein two or more reflectors are mounted on, or near, the first object and one ultrasonic transmitter/receiver is mounted on, or near, the second object said transmitter/receiver being composed of an array that produces a beam that can be steered by electronic means in accordance with information received from measurements of the angles to said reflectors until said angles are equal to predetermined values, thereby to achieve proper positioning of said objects relative to each other.

149. (Previously Presented) Endoscopic device according to claim 76, wherein said endoscopic device comprises an anvil unit of a stapler system, which is one of the objects to be aligned, and a stapler deployment unit containing a stapler cartridge, which is the other object.

150. (Previously Presented) Endoscopic device according to claim 94, wherein the air gaps, which occur between the tissue and the reflecting surfaces of the reflector, are filled with medical ultrasonic gel.

151. (Previously Presented) A method according to claim 105, wherein the distance between the transmitter and the reflector is determined by using a transducer capable of transmitting ultrasonic signals at least two different wavelengths and measuring the ratio of the intensities of the received signals at each wavelength.

152. (Previously Presented) A method according to claim 105, comprising mounting two or more ultrasonic transmitter/receivers, on, or near, the first of the objects, at a predetermined, fixed angle such that the transmitted beams intersect at a point in front of said first object and mounting one reflector on, or near, the second object said second object according to information received from intensity measurements until said reflector is located at said intersection point, thus achieving proper positioning of said objects relative to each other.

153. (Previously Presented) A method according to claim 105, comprising mounting two or more ultrasonic reflectors on, or near, the first of the objects and one ultrasonic transmitter/receiver on, or near, the second object, wherein said transmitter/receiver is composed of an array that produces a beam that can be steered by electronic means in accordance with information received from measurements of the angles to said receivers and said beam is steered until said angles are equal to predetermined values, thereby to achieve proper positioning of said objects relative to each other.

154. (Previously Presented) A method according to claim 138, comprising filling the air gaps, which occur between the tissue and the reflecting surfaces of the reflector with medical ultrasonic gel.

155. (Previously Presented) A method according to claim 105, wherein the distance between the transmitter and the reflector is measured by the following steps:

- generating a repetitive series of short electrical pulses or bursts of electrical pulses;
- amplifying said pulses;
- applying said amplified electric pulses to a transducer which converts the electrical energy to ultrasonic energy;
- allowing said ultrasonic energy to propagate, in the form of a relatively narrow beam, through a medium, until it encounters a reflector which directs it back towards said transducer from which it was emitted;
- receiving said ultrasonic energy by said transducer which converts it to an electrical signal;
- amplifying and filtering said electrical signal;
- digitizing said signal;
- temporarily storing the sampled data in a separate buffer of a first-in first-out (FIFO) buffer or fast memory;
- transferring the data from the FIFO or fast memory into the main computer memory;
- correlating the data in each buffer with a predefined reference signal pattern stored in a computer memory;
- determining the time of flight of the ultrasonic signal from the index of said buffer where the correlation with said reference signal has its maximum value; and,

- determining the distance from said time of flight.

156. (Previously Presented) Endoscopic device according to claim 76, wherein the relative alignment of the two objects is determined by use of triangulation techniques.

157. (Previously Presented) Endoscopic device according to claim 76, wherein the ultrasonic transducers are single element transducers.

158. (Previously Presented) Endoscopic device according to claim 76, wherein the ultrasonic transducers are composed of an array of elements.

159. (Previously Presented) Endoscopic device according to claim 76, wherein an aperture is placed before the transmitting ultrasonic transducers or a diverging transducer is used to cause the transmitted ultrasonic beam to diverge.

160. (Previously Presented) An endoscopic device according to claim 149, wherein the transducer that transmits only, receives only, or both transmits/receives is mounted into the stapler anvil unit or the cartridge unit.

161. (Withdrawn) A method according to claim 106, wherein the time of flight is measured by starting a clock simultaneously with the start of transmission of an ultrasonic signal and stopping said clock when the received signal rises above a predetermined threshold.

162. (Withdrawn) A method according to claim 106, wherein the time of flight is measured by transmitting an ultrasonic signal, sampling

the received signal, and carrying out a cross-correlation with a stored reference signal.

163. (Withdrawn) A method according to claim 112, comprising measuring the distance between the transmitter and the receiver by using a transducer capable of transmitting ultrasonic signals at two different wavelengths and measuring the time of flight when the distance is relatively large or measuring the spatial phase difference between the transmitted and received wave when the distance between transmitter and receiver is less than one wavelength.

164. (Withdrawn) A method according to claim 112, comprising determining the distance between the transmitter and the receiver by using a transducer capable of transmitting ultrasonic signals at least two different wavelengths and measuring the ratio of the intensities of the received signals at each wavelength.

165. (Withdrawn) A method according to claim 106, comprising using triangulation techniques to determine the relative distance and alignment of the two objects.

166. (Previously Presented) A method according to claim 152, comprising causing the intersection point of the transmitted beams to be located within the Fresnel zone of the ultrasonic transducers.

167. (Previously Presented) A method according to claim 152, comprising using focused ultrasonic transducers and mounting said ultrasound transducers such that the intersection point of the transmitted beams is located at the focal points of said transducers.

168. (Previously Presented) A method according to claim 155, comprising generating the predefined reference signal from a properly chosen mathematical function.

169. (Previously Presented) A method according to claim 155, comprising measuring an actual received ultrasonic signal and storing it in the computer memory to serve as the predefined reference signal.